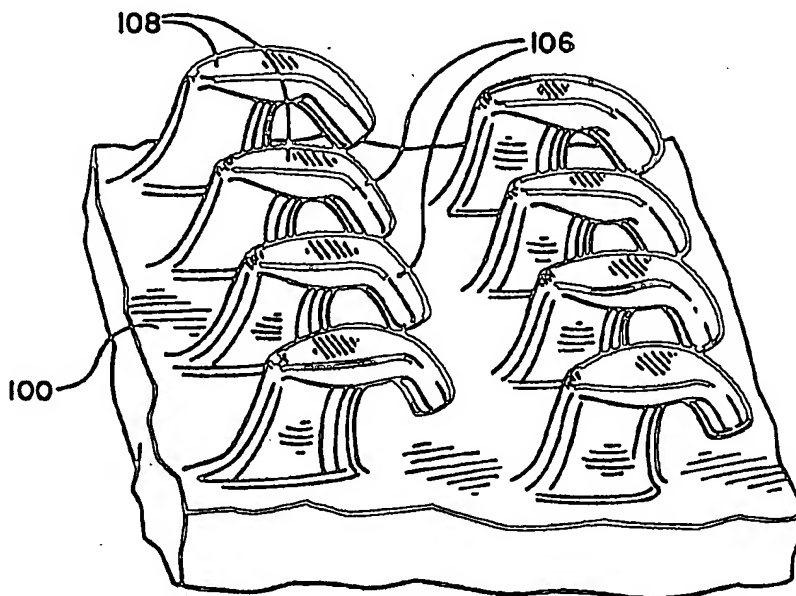


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US97/14619 <b>(22) International Filing Date:</b> 20 August 1997 (20.08.97) <b>(30) Priority Data:</b> 08/723,632      3 October 1996 (03.10.96)      US <b>(71) Applicant:</b> MINNESOTA MINING AND MANUFACTURING COMPANY [US/US]; 3M Center, P.O. Box 33427, Saint Paul, MN 55133-3427 (US). <b>(72) Inventors:</b> MILLER, Philip; P.O. Box 33427, Saint Paul, MN 55133-3427 (US). MELBYE, William, L.; P.O. Box 33427, Saint Paul, MN 55133-3427 (US). <b>(74) Agents:</b> BOND, William, J. et al.; Minnesota Mining and Manufacturing Company, Office of Intellectual Property Counsel, P.O. Box 33427, Saint Paul, MN 55133-3427 (US).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** J HOOK-TYPE HOOK STRIP FOR A MECHANICAL FASTENER**(57) Abstract**

A method of making a hook strip having J-shaped hooks that can be used as a mechanical fastener. The method includes using an initial substrate of material formed as an array of upstanding precursor stems having distal tips at their ends opposite a backing. In addition, a heat source adapted for heating and a mechanism for deforming stem tips is provided. The substrate is positioned relative to the heat source such that a portion of the upstanding stems on the array is heated. Subsequently, the substrate is moved to a position relative to the mechanism for deforming to create a hook strip of J-shaped hooks from the heated portion of the upstanding stems. In addition, an article of manufacture, made in accordance with the method, is provided which includes a hook portion of a hook-and-loop type of mechanical fastener.



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## 5 J HOOK-TYPE HOOK STRIP FOR A MECHANICAL FASTENER

Field of Invention

The invention relates generally to mechanical fasteners such as hook-and-loop fasteners. More particularly, the invention relates to J hook-type hook strips such as can releasably close a garment, e.g., a disposable garment such as a diaper or a hospital gown when attached to a suitable loop material.

15 Background

Hook-and-loop fasteners are widely used as garment fasteners. Commercial examples of these fasteners include those marketed under the VELCRO brand by Velcro USA Incorporated and under the SCOTCHMATE brand by Minnesota Mining and Manufacturing Company, St. Paul, Minnesota, which fasteners are made by a variety of methods. Early versions of the hook materials still available today are taught in U.S. Patent Nos. 2,717,437 and 3,009,235 (both by DeMestral), where a hook strip is made from specific warps of upstanding nylon loop pile. One leg of each loop is cut to leave an open-ended J-shaped hook, which is available to act as a fastening element.

U.S. Patent No. 3,594,865 (Erb) describes an injection molding technique for manufacturing a J-shaped hook strip of a hook-and-loop fastener. The technique taught is the use of a closed "loop material" having a large number of separate shallow "wire dies" formed in the loop material. While applying a vacuum to evacuate the "wire dies", the closed loop is passed through an extruder which forces molten plastic, such as nylon, into the dies while also impregnating a fabric web immediately beneath the loop material. Upon exiting from the extruder, excess resin is stripped from the surface of the wire dies. The resilient hooks then come progressively out of the dies, providing an

5 orderly array of hooks projecting from a plastic  
impregnated fabric web. Instead of using a fabric web,  
the apparatus can be modified to create a space beyond  
the wire dies into which the molten plastic can flow to  
form an all-plastic backing for the hooks. Another  
10 U.S. Patent No. 3,594,863 (Erb) relates to similar  
apparatus for producing a similar hook-bearing strip.  
These patents state that the disclosed method can  
produce a wider variety of shapes than a traditional  
solid die which is limited to shapes that taper from  
15 base to tip. However, this method would likewise be  
limited to shapes that must taper inward except in this  
case, from one outer face to an opposing face along the  
length of the hook. It is also difficult to impregnate  
the polymer in the supporting fabric behind the "loop  
20 material".

In U.S. Patent No. 3,718,725 (Hamano), the hook  
strip fastener of a hook-and-loop mechanical fastener  
is made from a fabric having an orderly array of  
upstanding loops. After inserting rods into rows of  
25 loops to maintain their upstanding position, platens or  
rollers apply heat and pressure to melt each loop at  
its summit and to press each free molten end to form a  
knob or head that can inter-engage with the loop strip  
of a hook-and-loop fastener. Because the knobs or  
30 heads have a mushroom appearance, this type of hook  
fastener is called "mushroom-type".

Mushroom-type hook fasteners are sometimes  
designed so that two like hook strips can be fastened  
together. Such self-mating types of mushroom-type  
35 mechanical fasteners are shown in U.S. Patent No.  
3,192,589 (Pearson) which calls the fastener  
"hermaphroditic" because its headed studs have both  
male and female characteristics when intermeshed. The  
Pearson fasteners can be made by molding a base from  
40 which integral headless studs project and then heat  
softening the tips of the studs.

5           The hermaphroditic mushroom-type mechanical  
fastener shown in U.S. Patent No. 4,290,174 (Kalleberg)  
is made with flexible, resilient, U-shaped  
monofilaments. The "central bight portion" of each  
monofilament is embedded in a flexible bonding layer so  
10 that two stems of the monofilament project normally  
from the surface of the bonding layer. There is a  
mushroom head at the tip of each stem formed by heating  
the terminal ends of the monofilaments, preferably  
formed of a polyolefin. The stems preferably are  
15 substantially uniformly spaced and of substantially  
equal length. Maximum disengagement force is achieved  
when the spacing between adjacent heads is less than  
their diameters and the minimum required for  
engagement.

20           U.S. Patent No. 3,408,705 (Kayser et al.) also  
shows mushroom-type mechanical fasteners having  
mushroom heads of several shapes. The "globe-shaped"  
(e.g., mushroom-shaped) heads are formed by heating  
cylindrical stems. J-hook shaped heads are formed by  
25 heating stems with wedge-shaped terminal ends.

Another procedure for continuously molding a J-  
shaped hook strip is described in U.S. Patent No.  
3,762,000 (Menzin et al). The process uses mold plates  
with cavities for molding upstanding J hook members or  
30 pile-like formations. The moldable plastic material is  
applied in two steps, first under high pressure to form  
the J hook-shaped pile-like formations while still in  
the cavities and secondly under lower pressure to form  
the strip constituting a base member so that the J  
35 hook-type protuberances are integrally attached. U.S.  
Patent No. 5,260,015 (Kennedy et al.) alters the Menzin  
et al. molding process by adding processing steps to  
firmly bond a backing material to the molded J hook-  
type extruded hook fastener strips.

5 U.S. Patent No. 4,984,339 (Provost et al.)  
discloses a molded J-shaped hook which has a profile  
defined by an inner smoothly contoured, generally  
concave face and an outer, generally convex face. The  
hook tapers smoothly and continuously downward in width  
10 from a sturdy base member to a free end. The hook is  
designed so that it will not deform to release a loop  
engaging the hook in shear at or below a desired  
applied force.

U.S. Patent No. 5,315,740 (Provost) discloses a  
15 molded hook shaped like that in U.S. Patent No.  
4,984,339 which is designed for use with a low profile  
loop closure system. A displacement volume is  
determined for the hook which is defined, generally, as  
a rectangular parallelepiped surrounding the hook tip.

20 There still exists a need for an improved method  
for making J hook-type hook strips without using time  
consuming and complicated molding processes to create J  
hook-shaped stems on a backing material.

## 25 Summary of Invention

The invention overcomes the above-identified  
limitations in the field by providing a simple method  
of making a hook strip having J-shaped hooks that can  
be used as a mechanical fastener. In a preferred  
30 embodiment, the method includes using a pre-existing  
substrate of material formed as an array of upstanding  
stems of thermoplastic material on a backing, the stems  
having tips at the ends opposite the end attached to  
the backing. The stem generally taper from base to tip  
35 and is preferably symmetrical along its length, e.g.,  
circular or polygonal. In addition, a heat source  
adapted for heating and a mechanism for deforming the  
stem tips is provided. The substrate is positioned  
relative to the heat source such that a portion of the  
40 tips of the upstanding stem array is heated.  
Subsequently or simultaneously, the substrate is moved

5 to a position relative to the mechanism for deforming  
the heated tip portions of the upstanding stem array to  
create a hook strip of J-shaped hooks. In addition, an  
article of manufacture made in accordance with the  
method, is provided which includes a J-shaped hook  
10 portion of a hook-and-loop type of mechanical fastener  
as described below.

#### Brief Description of Drawing

FIG. 1 is a schematic side view of a J-shaped hook  
15 strip in accordance with the present invention.

FIG. 2 is a schematic side view of upstanding  
stems used to form the J-shaped hooks of the invention.

FIG. 3 is a perspective view of a portion of a J-  
shaped hook strip in accordance with the present  
20 invention.

FIG. 4 is a schematic view of a method of making  
upstanding precursor stems and a backing.

FIG. 5 is a schematic view of a finishing process  
to form J-shaped hooks from upstanding stems on a  
25 backing.

FIG. 6 is a schematic view of a finishing process  
to form multi-directional J-shaped hooks from  
upstanding stems on a backing.

FIG. 7 is a schematic view of a finishing process  
30 to form multi-directional J-shaped hooks from  
upstanding stems on a backing.

FIG. 8 is a schematic view of a finishing process  
to form multi-directional J-shaped hooks from  
upstanding stems on a backing.

35 FIG. 9 is a scanning electron micrograph of a hook  
formed in accordance with Example 5 of the invention.

FIG. 10 is a scanning electron micrograph of a  
hook formed in accordance with Example 6 of the  
invention.

5        FIG. 11 is a scanning electron micrograph of a  
hook formed in accordance with Example 7 of the  
invention.

10        FIG. 12 is a scanning electron micrograph of a  
hook formed in accordance with Example 31 of the  
invention.

The figures, except for Figures 9 through 12, are  
idealized and are not necessarily to scale.

15    Detailed Description of Illustrative Embodiments

Figure 1 is a side view of a schematic  
representation of the present invention hook strip 100  
for a hook-and-loop mechanical fastener which is  
particularly well suited for use in garments and  
20    disposable articles. The hook strips are especially  
useful in refastenable fastening systems for disposable  
absorbent articles such as infant diapers, training  
pants, adult incontinent articles, and feminine hygiene  
products. The hook strips could also be used in  
25    fastening systems on hospital gowns and surgical  
drapes.

The invention hook strip is formed in a two step  
method. The form of the hook strip after each step is  
generally shown in Figure 2. The first step is to  
30    extrude tall upstanding precursor stems 102, integral  
with a film backing 104. The second step is the  
directional deformation of the stems 102 into J-shaped  
hooks 106.

In one process for performing the first step,  
35    stems 102 are made by extruding resin into cavities  
formed in a mold to form a substrate having an array of  
upstanding stems and an integral backing. To  
facilitate removal of the stems from the mold cavities,  
the stems are preferably tapered from base to tip. To  
40    form a stable base for the hooks and provide for  
uniform hook head formation the base is also preferably



5 of a shape which is generally symmetrically about its center such as polygonal or preferably circular. The stems as such have at least one axis of symmetry and preferably 2 or 3 or more axis of symmetry. A substantially circular shape is preferred in terms of  
10 stem stability, resistance to compressibility, stem and hook head manufacturability including uniform hook head formation. In one preferred embodiment, the stems are between about 0.1 millimeters (mm) to 5 mm in height.

Subsequently, in a preferred process for  
15 performing the second step a calender is used to form the stems 102 into J-shaped hooks. The calender gap is set to a height smaller than the combined height of the stems on the substrate taken with the backing thickness. The calender roller which deforms a portion  
20 of the stems is preferably heated to a temperature which will soften the thermoplastic material forming the stems. The heated calender roller is adjusted to run at a different speed than the web or substrate so that it wipes the stem passing through the calender  
25 gap. The wiping action on the stems with the heated roller simultaneously melts and deforms the tips which, if properly set, can form the deformed tips into J-shaped hooks as shown in Figure 3, which depicts a portion of a hook strip actually formed using the above  
30 calender method. These J-shaped hooks include a substantially planar upper surface 108.

This substantially planar surface 108 can be slightly non-planar across its length and width rising slightly to form a central depression or caldera-like  
35 structure. Alternatively, the sides or peripheral region surrounding the substantially flat planar surface 108 can fall off forming a slightly rounded hill or mesa-shaped structure. In any event, the top portions 108 of the hook heads are generally smooth and  
40 planar. This has been unexpectedly found to not significantly effect the ability of these hooks to

5 penetrate nonwoven, knitted or stitchbonded relatively  
open loop materials while the planar surface 108  
advantageously provides a non-irritating, tactily  
smooth surface. This planar upper hook surface 108  
makes the hook strip particularly well suited for use  
10 in disposable or temporary use garment applications  
where the mechanical fasteners are used close to or  
next to the wearer's skin.

Several parameters characterize the embodiment of  
J-shaped hooks 106, as shown in Figures 1-3 which can  
15 be produced by the above calender or other disclosed  
processes herein. These include a precursor stem  
height 110, stem diameter 114, final hook height 118,  
and distance between hooks 120. Also, defining the  
hooks are a hook opening width 122, hook opening height  
20 124, hook head thickness 128 at the base of the head  
107, hook head height 129, hook overhang 109 as well as  
the overall surface area of the planar top portions 108  
of the hooks. The film caliper or backing thickness  
132 further defines the J hook-type hook strip.

25 Hook strip 100 can be formed from virtually any  
thermoplastic material which can be extruded, as  
needed. Possible thermoplastic materials include  
polyolefins, such as polypropylenes, polyethylenes and  
copolymers and blends thereof, polyesters,  
30 polystyrenes, polyamides and the like.

Several alternative processes are possible to form  
J-shaped hooks 106 in the second step of the invention  
method. As noted above, one process involves passing a  
film backing having upstanding precursor stems 102  
35 through a calender gap where a heated roller is moving  
at a different speed than the substrate (i.e., either  
faster or slower than the substrate or even rotating in  
the opposite direction). Another process involves  
passing the film backing having upstanding precursor  
40 stems 102 through a stationary heated nip such that the  
forward motion of the film backing produces the wiping

5 deforming motion necessary to create the J-shaped  
hooks. Yet another process involves brushing a  
stationary film backing having upstanding precursor  
stems 102 with a stiff, heated rotating disk to form  
10 J-shaped hooks which are oriented circumferentially  
around a center point. A further process involves  
forming hooks oriented in more than one direction.  
This process involves passing the film backing having  
upstanding precursor stems 102 through a first slotted  
calender roll and a second slotted, or a second smooth  
15 calender roll, where the gaps in the first and second  
rolls are staggered, if both have gaps. The velocity  
of the two rolls, relative to the velocity of the  
precursor substrate, is, e.g., positive (e.g., faster)  
and negative (e.g., slower or opposite direction),  
20 respectively (to produce hooks curling substantially  
"up-web" and "down-web"). Also, in any of the above  
processes the heating portion of the second step could  
be performed independently from the deformation portion  
of the second step. Heating of the stem tips could be  
25 done by any suitable heat source including a radiant,  
parabolic, ultrasonic or focused infrared lamp type of  
source which could be used alone or in combination with  
a heated nip.

Advantages of the present invention method include  
30 the ability to manufacture J-shaped hooks 106 which are  
generally functionally comparable to conventional  
molded J hooks in performance, particularly when used  
in disposable garments and like uses, but which can be  
made faster and on a wider moving web or film backing  
35 than was previously possible with conventional molding  
or weaving techniques. This is primarily due to the  
combination of the ease of processing of the straight  
precursor stems 102 and the efficiency of the various  
deforming methods disclosed above. In addition, the  
40 performance of any given hook strip 100 can be readily  
tailored to a specific loop material by altering the

5 method to change hook parameters such as the hook opening height, hook opening width, final hook height or other structural parameters as will be discussed and taught in the examples below.

To have good flexibility and strength, the backing  
10 of the hook strip 100 is preferably from 0.025 mm to 0.512 mm thick and more preferably is from 0.064 mm to 0.254 mm thick, especially when hook strips 100 are made of polypropylene or a copolymer of polypropylene and polyethylene. However, virtually any thermoplastic  
15 resin that is suitable for extrusion molding may be used to produce the novel J-shaped hooks 106 and hook fastener strips 100. Thermoplastic resins that can be extrusion molded and should be useful in the invention include polyesters such as poly(ethylene  
20 terephthalate), polyamides such as nylon, poly(styrene-acrylonitrile), poly(acrylonitrile-butadiene-styrene), polyolefins such as polypropylene, and plasticized polyvinyl chloride. A particular preferred thermoplastic resin is an impact copolymer of  
25 polypropylene and polyethylene containing 17.5 percent polyethylene and having a melt flow index of 30, that is available as SRD7-560 from Union Carbide Company, Houston, Texas.

For some uses a stiffer thermoplastic material may  
30 be used, or the backing 104 can be coated with an optional layer of adhesive, such as a pressure sensitive adhesive 138, on its surface opposite the surface provided with the hooks 106, by which the material could be adhered to a substrate to help anchor  
35 the hook strip. Other suitable additional backing materials or additional layers include woven or non-woven materials, additional film layers, paper, or metal foil.

5            Preferably, when using the calender and like  
processes, a relative speed differential between the  
two calender rolls is between .02 meters per second and  
0.5 meters per second. In other embodiments, the heat  
source is a stationary heated nip, a heated disk, or a  
10 heated roller.

As discussed above, various processes may be used  
to manufacture upstanding stems 102, with Figure 4  
disclosing one apparatus for performing this process  
step. In Figure 4, a feed stream 144 of thermoplastic  
15 resin is fed into an extruder 146 from which a heated  
resin melt is fed through a die 148 to a rotating  
cylindrical mold 150. Cavities 158 in the cylindrical  
continuous surface of the mold 150 are optionally  
evacuated by an external vacuum system 164. The die  
20 148 has an output radius equal to that of the mold 150  
in order to provide a seal between the die 148 and the  
mold 150. Rapid flow of the resin into the mold  
cavities 158 induces molecular orientation parallel to  
the direction of flow, and the mold 150 is preferably  
25 water-cooled (cooling mechanism not shown) to provide  
rapid quenching to maintain this orientation in place.

The solidified resin is stripped from the mold 150 by  
a stripper roll 168 as a substrate formed as a web or  
film backing 104 that has an array of upstanding  
30 precursor stems 102. Film backing 104 can either be  
wound into a roll for storage or fed directly into a J-  
shaped hook forming apparatus.

Once the film backing 104 with upstanding  
precursor stems 102 is produced, any of the above  
35 described processes may be used to form the J-shaped  
hooks 106, for example, the processes performable on  
the Figure 5 apparatus and discussed in detail above.  
The apparatus depicted in Figure 5 includes a capping  
station with a gap as well as chilled roller 170 and

5 heated roller 172. One surface of film backing 104 is adjacent to and passes over the chilled roller 170 and portions of the stems 102 contact the heated roller 172. The surface of heated roller 172 generally is moving in the same direction that film backing 104 is  
10 traveling but at a different speed ranging from faster to slower, which would include the roller being completely stopped and in an extreme condition the roller 172 moving in the direction opposite film backing 104 travel. This speed differential will,  
15 primarily, determine the degree of rolling or curl imparted to each stem 102 as the distance between the roller surfaces is reduced.

Figure 6 discloses a deformation process which incorporates an apparatus capable of forming J-shaped  
20 hooks 106 from stems 102 with hook orientations in two or more directions and at many combinations of angles with respect to film backing 104 centerline 202. This deformation process mechanism uses a shuttle mechanism and includes a plurality of idlers 210, 214, 218 and  
25 222, which are attached to the same shuttle mechanism frame. This shuttle mechanism, including the idlers, moves up and down (in the plane of the figure) or with and against the direction of travel of film backing 104. When the shuttle mechanism velocity is matched to  
30 the line speed of film backing 104 and is moving against the direction of travel of film backing 104, then film backing 104 moves laterally at up to twice line speed. When the shuttle mechanism moves with the direction of travel of film backing 104, then at the  
35 appropriate shuttle mechanism speed the film backing 104 can stop moving laterally. While film backing 104 has stopped moving laterally, but is moving in the original direction of travel at line speed, it is

5 brought in contact with the first hook forming device  
226.

Device 226 is a heated roll with narrow, evenly spaced, elevated rings 228 on its surface. The surface of these rings can be moving in the same or different  
10 direction than the stems relative to device 226, as discussed above. This speed differential will in part determine the degree of rolling or curl imparted to each contacted precursor stem 102 when the distance between the rings and the film backing approaches its  
15 closest point.

Hook forming device 226 forms narrow rows 243 of J-shaped hooks 106 as film backing 104 passes by. These hooks 106 may be oriented at a 45 degree angle to substrate 104 centerline 202. A second like hook  
20 forming device 250 may make rows 255 of J-shaped hooks 106 oriented at a 45 degree angle from substrate 104 centerline 202 or 90 degrees from the first rows at the same time, when the film backing 104 stops moving laterally. Smooth heated roller 260 then forms any  
25 remaining upstanding stems into regions or rows 264 of J-shaped hooks 106 which are oriented 135 degrees from either of the other two rows (225 and 243).

When the distance between rows of stems 102 entering this embodiment of a shuttle mechanism is  
30 defined as X, the rings on the first hook forming device 226 are 2X wide and on 6X centers, and the rings on the second hook forming device 250 are 3X wide and on 6X centers, then an equal number of J-shaped hooks 106 will be oriented in each of the three directions.  
35 As will be appreciated by those skilled in the art, this process could be expanded to different angles of orientation or more directions of orientation.

Yet another deformation process for forming J-shaped hooks 106 having more than one direction of

5 orientation is shown in Figure 7 and Figure 8. This  
device may comprise a stationary heated blade 270 or  
shoe with teeth centered between every second row of  
stems 102. Alternatively, as shown in Fig. 8, a heated  
reciprocating blade 271 may be used. This blade has  
10 long, narrow teeth which give bi-directional  
orientation closer to 180 degrees. In each embodiment,  
the relative motion deforming principles of the  
invention operate as described above to create the  
distinctive hook shapes shown, for example, in Figure  
15 3.

The invention may be alternatively described as a  
method of making a hook strip having J-shaped hooks  
that can be used to perform hook and loop types of  
mechanical fastening requirements. In a preferred  
20 embodiment, the method includes using a pre-existing  
extruded integral substrate, such as a film backing, of  
material formed with an array of upstanding stems  
having tips at their ends opposite the backing, the  
backing and stems being simultaneously extruded. The  
25 stems being generally upstanding, continuously tapered  
protrusions without any fiber engaging portions at the  
tips. Preferably, the pre-existing substrate includes  
a solidified thermoplastic resin layer forming the  
backing with the same thermoplastic material also  
30 forming the array of upstanding stems. Also, the pre-  
existing substrate may consist of a single substrate  
having an array of upstanding stems of differing  
heights.

In addition, a heat source adapted for heating and  
35 a mechanism for deforming stem tips is provided. The  
substrate is positioned relative to the heat source  
such that an upper portion, preferably a distal end  
portion, including the stem tips, of a plurality of  
upstanding stems is heated. Subsequently or



5 simultaneously, the substrate is moved to a position  
relative to the mechanism for deforming to create a  
hook strip of J-shaped hooks from the heated portion of  
the upstanding stem array. During the moving of the  
substrate, a top surface is formed, with a  
10 substantially planar upper surface. Also the hooked  
portion of each of the J-shaped hooks is created by the  
mechanism for deforming the heated portion of the array  
of upstanding stems. Also when the substrate is  
moving, a deformed portion of each of the plurality of  
15 J-shaped hooks is asymmetrically oriented relative to a  
substantially orthogonally connected non-deformed  
upstanding stem portion of each of the plurality of J-  
shaped hooks. Alternatively, when the substrate is  
moving, the heated portion of the array of upstanding  
20 stems on the substrate may be deformed in different  
orientations as discussed above. This is possible due  
to the independence of the deforming step from the  
step(s) necessary to produce the precursor stems. It  
will also be appreciated by those skilled in the art  
25 that another portion of the array of upstanding stems  
on the substrate may be deformed into shapes other than  
J-shaped hooks during the moving of the substrate.  
Throughout the process of making the hook strip, a  
portion of each of the upstanding stems is not deformed  
30 and preferably retains an initial molecular  
orientation.

In addition, an article of manufacture, made in  
accordance with the above method is provided which  
includes a hook portion of a hook-and-loop type of  
35 mechanical fastener. The deformed portion of each of  
the array of upstanding stems may be a generally  
tapered distal hook portion which has been deformed so  
that it extends from a generally downwardly projecting  
tip (however, in some cases the tip will project

5 downward only slightly) up to a substantially planar  
upper portion 108 of the hook portion which is then  
connected to an upstanding stem portion. The final  
average hook height 118 (or height of the deformed  
stem) may range from between 0.05 mm and 4.0 mm.

10 Furthermore, a density of hooks from the array of  
heated upstanding stems may range between 4 stems/cm<sup>2</sup> to  
about 2000 stems/cm<sup>2</sup>. Preferably, for convenience, the  
article may be wound up into a roll for convenient  
storage and shipment and then cut to desired lengths of  
15 hook strips 100 as needed. When wound in a roll, the  
substantially planar upper surface 108 of each of the  
J-shaped hooks on the article is less likely to  
penetrate any adhesive layer on the surfaces opposite  
the hooks than prior hooks formed into distinct peak  
20 forms. The substantially planar upper surface 108 also  
mitigates against deformation of the film backing 104,  
due to the distribution of pressure applied against  
individual hooks if the hook strips are wound in a roll  
or the like. Also, the substantially planar upper  
25 surface 108 of each of the J-shaped hooks creates a  
hook strip having a tactile feel which is less rough  
than other hook and loop types of fasteners, e.g., more  
like the feel of a flat film and is much less likely to  
cause chaffing and skin irritation.

30

5 Example 1

A roll having a plurality of J-shaped hooks 106, such as those shown in Figure 3, was made under the conditions of Table I with the resulting dimensions of Table II below. In Table I, Relative Speed means the speed of the heated roll relative to the substrate line speed (so in Table 1, -70 percent means the heated roll is moving in an opposite direction to the substrate at a speed of 14 feet/minute).

15 Table I

Heated Calender Roll Temperature	290°F
Chilled Calender Roll Temperature	50°F
Line Speed of Substrate	6.1 meters/minute (20 feet/minute)
Gap Between Heated and Chilled Roll	.25 mm (10 mils)
Relative Speed	-70 percent

20 Table II

Distance Between Hooks	64 mm (25 mils)
Hook Density	248 hooks/cm <sup>2</sup>
Film Backing Caliper	.09 mm (3.5 mils)
Stem Diameter	.20 mm (8 mils)
Precursor Stem Height	.50 mm (18.5 mils)
Hook Height	.25 mm (11 mils)
Hook Opening Height	.16 mm (6 mils)
Hook Opening Width	.16 mm (6 mils)
Hook Thickness	.10 mm (4 mils)

5 The tests used independent hook strips 100 of a  
2.54 centimeter (cm) by 10.16 cm size. The tests  
included a shear strength test using ASTM D-5169 and a  
135 degree peel test conducted in the machine direction  
(MD) (for best hook engagement) and in the cross web  
10 direction (CD) (for nominal hook  
engagement). The peel test consisted of a 135 degree  
peel from a test patch of XML-4069 loop (commercially  
available from Minnesota Mining & Manufacturing  
Company) at a peel rate of 30.5 cm per minute. The  
15 hook samples were rolled down onto the loop using five  
passes of a 2.04 kilogram (4.5 pound) roller. The  
tests were run at 70°F and 50 percent relative  
humidity. The results are shown in Table III.

20 Table III

	CD	MD
Peak Peel (grams/cm)	63 ± 9	78 ± 16
Shear (grams/cm <sup>2</sup> )	487 ± 84	835 ± 67

Examples 2 through 17

In these examples, a device as shown in Figure 5 was employed where the top heated calender roll 172 was heated with oil; the bottom calender roll 170 was chilled with water. Both rolls were chrome plated and approximately 10 inches in diameter. The bottom chilled calender roll was fixed and 3 inch diameter pistons were used to position the heated calender roll.

The gap between the heated calender roll and the chilled calender roll was set with a screw and stop set up. For the experiments described below, a pressure of 40 psi in the pistons was sufficient to prevent the heated roll from floating (opening the gap) when the precursor material was calendered.

5       The speed of the heated roll (s2) could be set  
independently of the speed of the chilled roll (s1).  
The overspeed is the difference between s1 and s2. For  
example, a 110 percent overspeed means that the heated  
roll was turning 10 percent faster than the chilled  
10 roll; a -70 percent overspeed means that the heated  
roll was turning backwards at 70 percent of the speed  
of the chilled roll.

In all the experiments, the line speed of the web  
was slaved to the chilled roll speed. Therefore, the  
15 surface velocity,  $v$ , of the heated roll at the tips of  
the stems is determined by the formula:

$$v = s1 - s2$$

For Examples 2 through 17 summarized in Table IV  
below, the chilled roll was 17°C (60°F) with the nip  
20 pressure set at 276 KPa (40 psi). The web total  
caliper, backing thickness and stem height, was  
approximately 0.61 mm (0.024 inches).

5

Table IV

Example	Gap (inches)	Hot Roll Temp (°F)	Line Speed (fpm)	Overspeed (percent).	Surf. Velocity (fpm)
2	0.014	305	20	-70	34
3	0.014	305	20	0	20
4	0.014	305	10	-240	34
5	0.014	305	10	-100	20
6	0.014	285	20	-70	34
7	0.014	285	20	0	20
8	0.014	285	10	-240	34
9	0.014	285	10	-100	20
10	0.019	305	20	-70	34
11	0.019	305	20	0	20
12	0.019	305	10	-240	34
13	0.019	305	10	-100	20
14	0.019	285	20	-70	34
15	0.019	285	20	0	20
16	0.019	285	10	-240	34
17	0.019	285	10	-100	20

For each of the formed hook strip materials the hook dimensions were measured by an optical microscope (an average of 6 measurements).  $A_1$  and  $A_2$  are the length and width respectively of the hook upper surface 108. B is the hook head height 129. C is the hook overhang 109. D is the hook head thickness 128 at the base of head 107 and E is the combined backing thickness 132 and hook height 118. These measurements are set forth in Table V.

5           Table VI summarizes the average peel force values  
for Examples 1 through 16. The peel values were  
measured using ASTM D-5170 (describe briefly) against a  
nonwoven material (3M XML-5167 available from 3M  
Company, St. Paul, MN) loop with the hooks on the strip  
10 oriented in the cross direction to the peel direction  
of the hook strip (which results in generally lower  
peel values).

The results shown in Table VI indicate that the  
hook head height has a significant effect on peel  
15 performance with decreasing head height generally  
increasing peel performance. In Examples C4 and C5 the  
hook head extended and contacted to the base film 104  
leaving no gap for fibers to get under the head, hence  
the nil peel values. In Example 2, although there was  
20 little gap (E-B) between the hook head and the base  
film the hook head was very thin at its distal end such  
that it was relatively easy for fibers to push it out  
of the way. Otherwise E-B was related to B such that  
as it increased (e.g., B decreased) peel performance  
25 likewise increased.

Generally, as C increased, peel performance also  
increased. However, the measurement of this value was  
very inaccurate as it was measured from the top of the  
hook making it difficult to differentiate and even when  
30 the measured value was nil there was likely still some  
overhang from the tip of the deformed hook head.

5

Table Y

Exam- ple	A <sub>1</sub> (mils)	A <sub>2</sub> (mils)	B (mils)	C (mils)	D (mils)	E (mils)	A <sub>1</sub> ×A <sub>2</sub> (sq mils)	E-B (mils)
2	10.7	12.4	7.3	0	1.9	8.3	132.68	1
3	10.1	13	5.4	1.4	1.9	8.4	131.3	3
4	12.9	12.4	6.8	1.3	1	6.8	159.96	0
5	13.5	12.9	6.7	0.5	1.6	6.7	174.15	0
6	11.2	12	4.8	1.6	2	9	134.4	4.2
7	12.1	11.4	2.3	3.6	2.1	8.9	137.94	6.6
8	10.5	11.2	6.1	0	2.1	8.8	117.6	2.7
9	10.9	10.7	6.5	0.1	2.5	8.6	116.63	2.1
10	10.9	10.4	3.9	2	1.8	11.1	113.36	7.2
11	10.6	10.2	4.1	2.5	2.1	11.2	108.12	7.1
12	10.3	10.1	6.4	0.8	1.6	10.4	104.03	4
13	13	9.8	5.5	0.9	1.9	10.1	127.4	4.6
14	9.2	11.4	2.9	1.2	2	10.5	104.88	7.6
15	10.1	11	1.9	3	1.9	11.3	111.1	9.4
16	8.7	10.6	4.7	0.9	2.3	10.6	92.22	5.9
17	8.9	10.8	4.8	1.2	2.5	11.5	96.12	6.7



5

Table VI

Example	Average Peel (g/cm)
2	5.4
3	13.7
4	0
5	0
6	19.9
7	20.2
8	4
9	7.2
10	12.3
11	18.6
12	4.3
13	7.9
14	15.9
15	19.8
16	8.3
17	12.3

Examples 18 through 33

For Examples 18 through 33 the gap width was changed to 0.5 mm (0.019 in.). Otherwise the examples were run on the equipment described for Examples 2 through 17 with the conditions set forth in these examples and in Table VII below.

5

Table VII

Example	Caliper (inches)	Hot Roll Temp (°F)	Line Speed (fpm)	Overspeed (percent)	Surf. Velocity (fpm)
18	0.024	305	20	-70	34
19	0.024	305	20	0	20
20	0.024	305	10	-240	34
21	0.024	305	10	-100	20
22	0.024	285	20	-70	34
23	0.024	285	20	0	20
24	0.024	285	10	-240	34
25	0.024	285	10	-100	20
26	0.020	305	20	-70	34
27	0.020	305	20	0	20
28	0.020	305	10	-240	34
29	0.020	305	10	-100	20
30	0.020	285	20	-70	34
31	0.020	285	20	0	20
32	0.020	285	10	-240	34
33	0.020	285	10	-100	20

The dimensions of the Examples 18 through 33 hook materials were then measured as were Examples 2 through 17 and as set forth in Table VIII. The reported measured values were the average of six different hooks.

5

Table VIII

Exam- ple	A <sub>1</sub> (mils)	A <sub>2</sub> (mils)	B (mils)	C (mils)	D (mils)	E (mils)	A <sub>1</sub> xA <sub>2</sub> (sq mils)	E-B (mils)
18	9.5	9.5	5.3	1.6	2.6	14.4	90.25	9.1
19	9	8.9	4.8	1.7	2.2	14.9	80.1	10.1
20	20.5	4.3	10.3	13.2	2.4	13.3	88.15	3
21	22.3	4.2	8.4	11.4	2	14	93.66	5.6
22	8	8.6	4	2	2.3	15.4	68.8	11.4
23	8.9	8.7	3.5	3	2.6	15.6	77.43	12.1
24	7.7	8.4	5.3	0.2	2	15.3	64.68	10
25	7.7	8.7	4.7	0.9	1.9	14.3	66.99	9.6
26	10.9	10.4	3.9	2	1.8	11.1	113.36	7.2
27	10.6	10.2	4.1	2.5	2.1	11.2	108.12	7.1
28	10.3	10.1	6.4	0.8	1.6	10.4	104.03	4
29	13	9.8	5.5	0.9	1.9	10.1	127.4	4.6
30	9.2	11.4	2.9	1.2	2	10.5	104.88	7.6
31	10.1	11	1.9	3	1.9	11.3	111.1	9.4
32	8.7	10.6	4.7	0.9	2.3	10.6	92.22	5.9
33	8.9	10.8	4.8	1.2	2.5	11.5	96.12	6.7

These examples were then tested for peel performance as were Examples 18 through 33. The same trends were noticed.

10

5

Table IX

Sample	Average Peel (g/cm)
17	16.8
18	17.7
19	5.9
20	4.8
21	14.9
22	16.1
23	413.7
24	14.1
25	12.3
26	18.6
27	4.3
28	7.9
29	15.9
30	19.8
31	8.3
32	12.3

5 What is claimed:

1. A method of making a hook strip having a plurality of J-shaped hooks that can be used as a mechanical fastener, the method using an initial  
10 substrate of material formed as a backing and an array of upstanding precursor stems having distal tips at ends opposite the backing, the method comprising the steps of:
  - 15 (a) providing a heat source adapted for heating a plurality of stem tips;
  - (b) providing a mechanism for deforming a plurality of stem tips;
  - (c) positioning the substrate relative to the heat source such that a distal portion of a  
20 plurality of upstanding stems is heated; and
  - (d) moving the substrate to a position relative to the mechanism for deforming to create a hook strip having a plurality of J-shaped hooks created by the deformation of the  
25 heated portion of the array of upstanding stems on the substrate.
2. The method of claim 1 wherein the moving step includes forming a substantially planar upper surface  
30 portion on a deformed portion of each of the plurality of J-shaped hooks.
3. The method of claim 2 wherein the moving step further includes asymmetrically orienting a deformed  
35 portion of each of the plurality of J-shaped hooks relative to a substantially non-deformed portion of a precursor stem of each of the plurality of J-shaped hooks.

- 5           4.    The method of claim 3 wherein the deforming  
             creates a hook portion that is partially orthogonally  
             oriented relative to the non-deformed portion.
5.    The method of claim 1 wherein the step of  
10           providing the heat source comprises providing a heated  
             calender roll.
6.    The method of claim 5 wherein the positioning  
             step includes positioning the substrate on another  
15           calender roll.
7.    The method of claim 6 wherein the calender  
             roll on which the substrate is positioned is a chilled  
             calender roll.  
20
8.    The method of claim 6 wherein the calender  
             roll on which the substrate is positioned is adjacent  
             to the heated calender roll and is rotated at a  
             different speed than the heated calender roll.  
25
9.    The method of claim 8 wherein a relative  
             speed differential between the two calender rolls is  
             between 0.5 meters per second and .02 meters per  
             second.  
30
10.   The method of claim 6 wherein the calender  
             roll on which the substrate is positioned is adjacent  
             to the heated calender roll and is rotated in a  
             different direction than the heated calender roll.  
35

5           11. The method of claim 1 wherein the step of  
providing the heat source comprises providing a heat  
source selected from the group consisting of a  
stationary heated nip, a heated disk, a heated roller,  
a radiant heat source, a parabolic heat source,  
10 ultrasonic heat source, and a focused infrared heat  
source.

          12. The method of claim 11 wherein the  
positioning step includes the heated disk heat source  
15 contacting the substrate in a circular relative motion  
manner to form a plurality of J-shaped hooks having a  
circular deformation pattern in plan view.

          13. The method of claim 1 wherein the moving step  
20 includes deforming the heated portion of the array of  
upstanding stems on the substrate in different  
orientations.

          14. The method of claim 13 wherein the step of  
25 providing the heat source includes providing a heated  
disk having a deforming surface with a circumferential  
pattern of ridges.

          15. The method of claim 1 wherein the initial  
30 substrate is a single substrate having an array of  
upstanding stems of differing heights.

          16. The method of claim 1 wherein the step of  
providing the heat source includes providing a  
35 plurality of heated slotted calender rolls adapted for  
deforming a portion of the array of upstanding stems on  
the initial substrate in differing orientations.

- 5           17. The method of claim 1 wherein the moving step includes moving the substrate so that a centerline of the substrate is non-orthogonal to a centerline of the mechanism for deforming the heated portion of the array of upstanding stems.
- 10           18. The method of claim 1 wherein the moving step includes deforming a portion of the array of upstanding stems into shapes other than J-shaped hooks.
- 15           19. A hook strip article for use as a mechanical fastener said hook strip having a plurality of J-shaped hooks that can be used as a mechanical fastener, the hook strip manufactured by using an initial substrate of a solidified thermoplastic resin formed as a film  
20 backing and an array of upstanding precursor stems of the same solidified thermoplastic resin having distal tips at ends opposite the film backing, the film backing and the precursor stems being extruded simultaneously, each J-shaped hook formed from an  
25 upstanding precursor stem and having a substantially planar upper surface formed on an asymmetrically oriented deformed portion.
- 30           20. The article of claim 19 wherein the initial substrate comprises an integral substrate forming the backing and the array of upstanding substantially symmetrical stems.
- 35           21. The article of claim 19 wherein the initial substrate comprises the backing and the array of upstanding stems and the symmetrical stems have more than two axis of symmetry.



5           22. The article of claim 19 further comprising an additional material connected to the backing of the initial substrate.

10           23. The article of claim 19 wherein a deformed portion of each of the array of heated upstanding stems comprises a downwardly projecting distal tip.

15           24. The article of claim 19 wherein a final hook height of deformed stems from the array of heated upstanding stems ranges between 0.05 millimeters and 4.0 millimeters.

20           25. The article of claim 19 wherein a hook density of deformed stems from the array of heated upstanding precursor stems ranges between 4 stems per centimeter squared and 2000 stems per centimeter squared.

25           26. The article of claim 19 wherein the backing of the hook strip further includes an adhesive layer, is substantially continuous, and is wound into a roll for convenient storage and shipment.

30           27. The article of claim 19 wherein the array of upstanding stems is configured such that two different portions of the substrate may interengage to provide a mechanical fastener.

35           28. The article of claim 19 in which the article comprises a structure selected from the group of structures including fasteners for garments, refastenable fastening systems for disposable absorbent articles, fastening systems for surgical drapes, and attachment systems for abrasive articles.

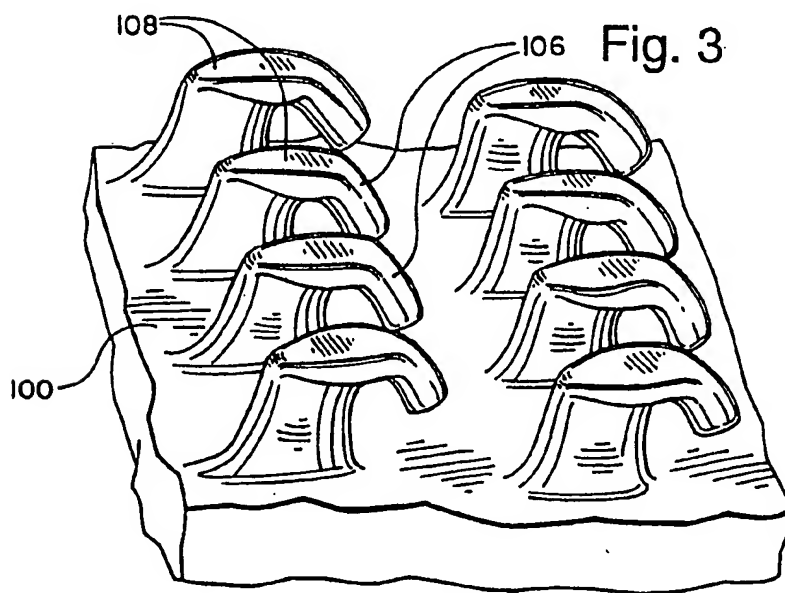
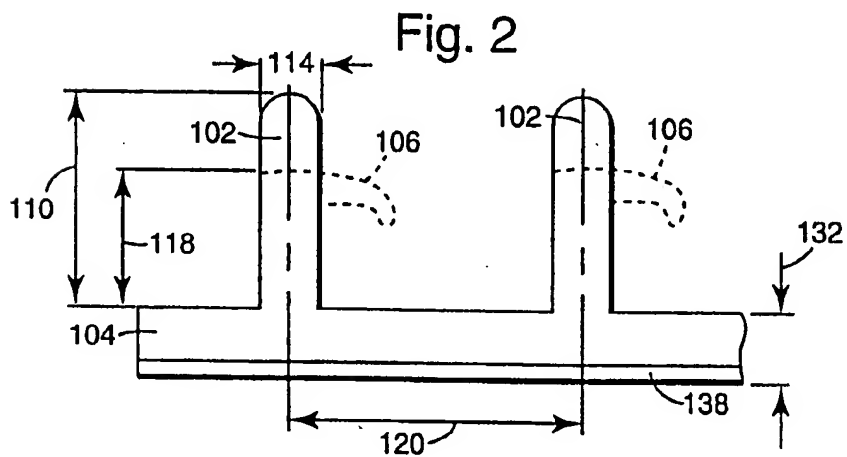
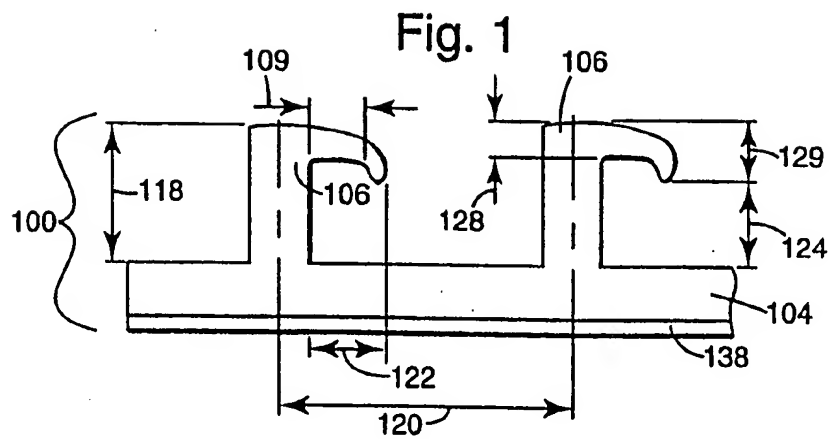


Fig. 4

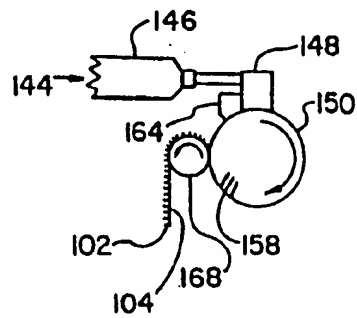


Fig. 5

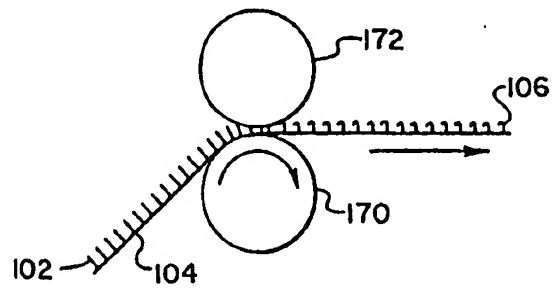


Fig. 6

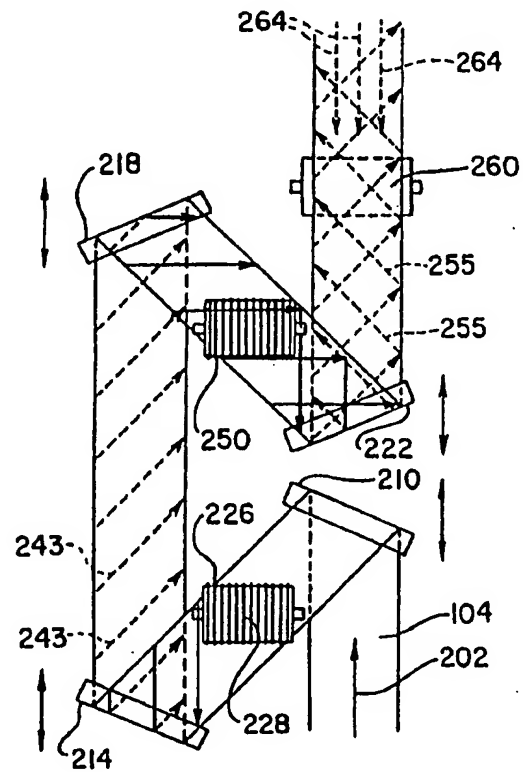


Fig. 7

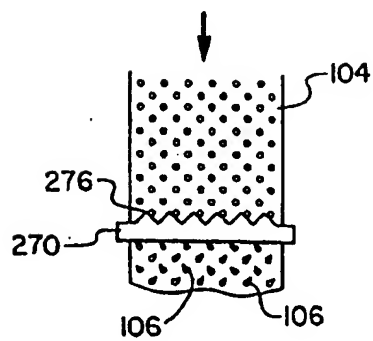
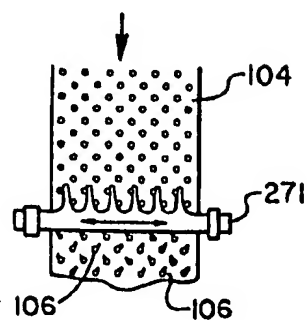


Fig. 8



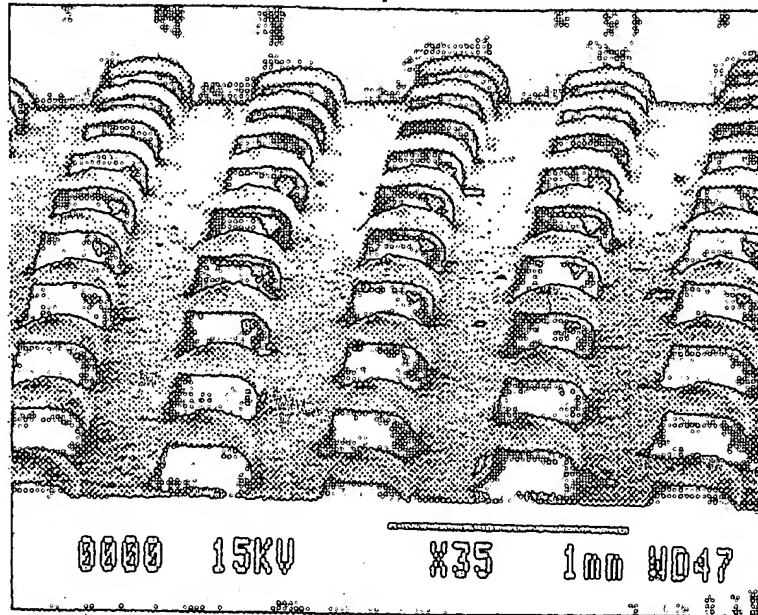


Fig. 9

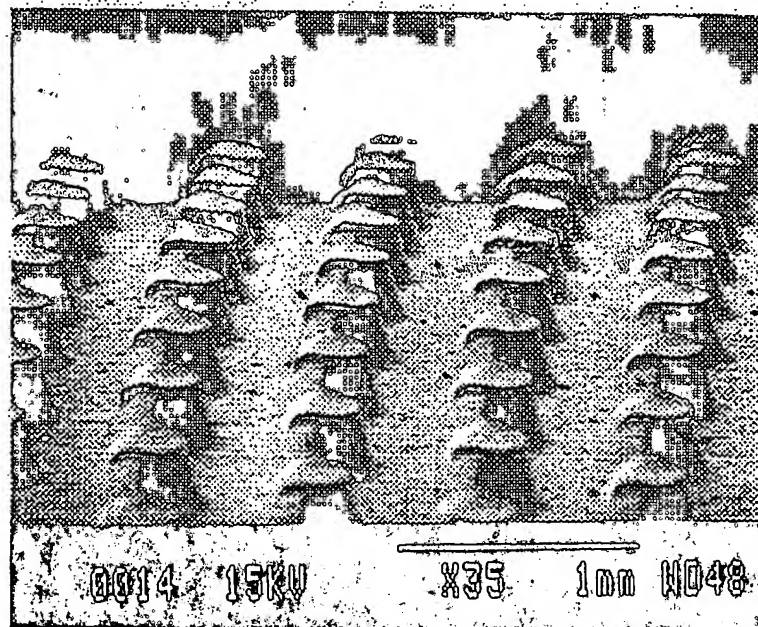


Fig. 10

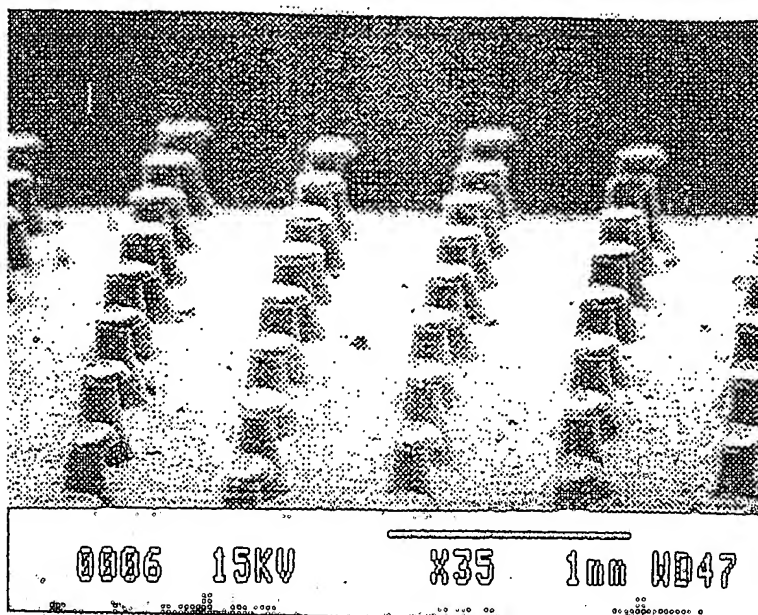


Fig. 11

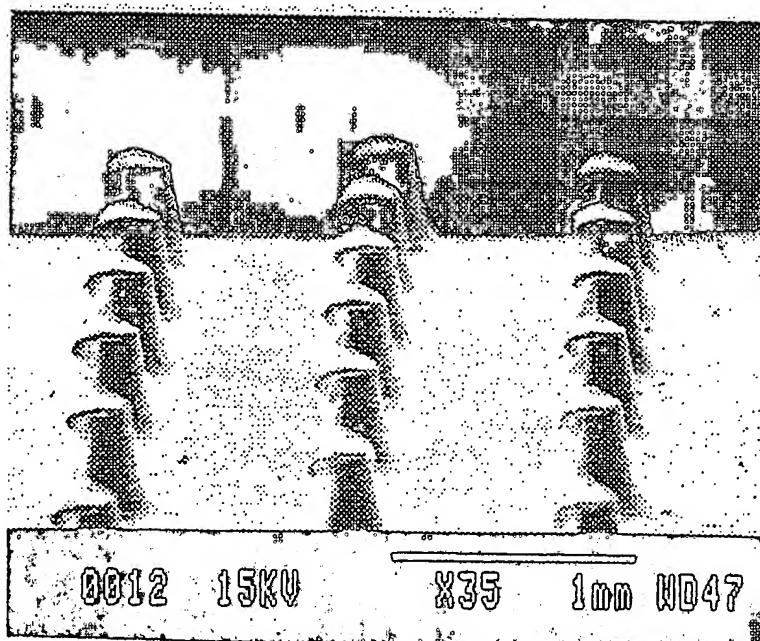


Fig. 12

## INTERNATIONAL SEARCH REPORT

Intern. Appl. Application No

PCT/US 97/14619

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A44B18/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A44B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 505 747 A (CHESLEY JASON A ET AL) 9 April 1996 see column 4, line 47 - column 7, line 21 see column 8, line 44-56 see figures 1-3,5-7	1,3-5, 11,18
Y	---	2,15, 19-28
Y	GB 2 009 257 A (VELCRO USA) 15 June 1979 see page 5, line 8-22; figures 8-10	2,19,23
Y	WO 94 23610 A (MINNESOTA MINING & MFG) 27 October 1994 see claims 1,7; figure 8 ---	20-22, 24-28
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

26 November 1997

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Kock, S

# INTERNATIONAL SEARCH REPORT

Intern. Appl. Application No  
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